

## CLAIMS

What is claimed is:

1. A code division, multiple access (CDMA) receiver having an input node coupled to a plurality  $S$  of receive antennas that receive signals from a plurality  $N$  of transmit antennas, comprising:

$J$  correlators outputting soft symbol decisions, where  $J=N$  times a number of detected physical channels;

$N$  equalizers each having an input coupled to said input node and an output coupled to as many correlators as there are detected physical channels of the said  $J$  correlators;

a channel estimator having an input coupled to said input node and  $N$  outputs representing a channel estimate for each of said transmit antennas; and

a unit for computing coefficients for each of said  $N$  equalizers, said unit having a first input coupled to said input node, second inputs coupled to said  $N$  outputs of said channel estimator, and third inputs for receiving estimates of received chip energy per transmit antenna, said unit computing said coefficients so as to operate said equalizers for simultaneously suppressing inter-antenna interference and multiple user interference such that the suppression of the inter-antenna interference and the multiple user interference is balanced with respect to their deteriorating impact on symbol estimates.

2. A CDMA receiver as in claim 1, where said unit operates to compute

$$\mathbf{v}_n = \left[ \mathbf{R} + \sum_{m=1}^N (E_{d,m} G_d - E_{T,m}) \mathbf{p}_m \mathbf{p}_m^H \right]^{-1} \mathbf{p}_n,$$

where  $\mathbf{v}_n$  is a vector containing  $L$  filter coefficients for the equalizer assigned to transmit antenna  $n$ ,  $\mathbf{R}$  is an estimate of received signal covariance matrix averaged over a scrambling sequence,  $E_{d,m}$  is the received energy per chip for a physical channel from transmit antenna  $m$ ,  $G_d$  is the spreading factor for a physical channel,  $E_{T,m}$  is the total

received energy per chip for the physical channel from the transmit antenna  $m$ ,  $()^H$  is the Hermitean and  $\mathbf{p}_n$  is the channel impulse response for transmit antenna  $n$ , where vector  $\mathbf{p}_n$  contains the impulse response for all receive antennas.

3. A CDMA receiver as in claim 1, where said unit operates at a chip level.
4. A CDMA receiver as in claim 1, where said unit operates at a symbol level.
5. A CDMA receiver as in claim 1, where said unit updates said equalizer coefficients continuously using a least mean squares (LMS) or a recursive least squares (RLS) based algorithm.
6. A CDMA receiver as in claim 1, where adaptation of the equalizer coefficients is performed at a symbol rate at the output of a correlator bank
7. A CDMA receiver as in claim 1, where said unit updates said equalizer coefficients periodically at High Speed Downlink Packet Access (HSDPA) transmission time intervals (TTI).
8. A CDMA receiver as in claim 1, where said CDMA receiver comprises a Space Time Transmit Diversity (STTD) architecture receiver.
9. A CDMA receiver as in claim 1, where said CDMA receiver comprises a Double Space Time Transmit Diversity (STTD) architecture receiver.
10. A CDMA receiver as in claim 1, where said CDMA receiver performs equalization at a symbol rate.
11. A CDMA receiver as in claim 1, where said CDMA receiver operates with one of orthogonal or non-orthogonal space-time codes.
12. A method to operate a code division, multiple access (CDMA) receiver that has an

input node coupled to a plurality  $S$  of receive antennas that receive signals from a plurality  $N$  of transmit antennas,  $J$  correlators outputting soft symbol decisions, where  $J=N$  times a number of detected physical channels,  $N$  equalizers each having an input coupled to said input node and an output coupled to an associated one of said  $J$  correlators, comprising:

generating a channel estimate for each of said transmit antennas; and

determining coefficients for each of said  $N$  equalizers in accordance with signals appearing at said input node, said channel estimates, and estimates of received chip energy per transmit antenna, said coefficients operating said equalizers for simultaneously suppressing inter-antenna interference and multiple user interference so that the suppression of the inter-antenna interference and the multiple user interference is balanced with respect to their deteriorating impact on symbol estimates.

13. A method as in claim 12, where determining coefficients solves:

$$\mathbf{v}_n = \left[ \mathbf{R} + \sum_{m=1}^N (E_{d,m} G_d - E_{T,m}) \mathbf{p}_m \mathbf{p}_m^H \right]^{-1} \mathbf{p}_n,$$

where  $\mathbf{v}_n$  is a vector containing  $L$  filter coefficients for the equalizer assigned to transmit antenna  $n$ ,  $\mathbf{R}$  is an estimate of received signal covariance matrix averaged over a scrambling sequence,  $E_{d,m}$  is the received energy per chip for a physical channel from transmit antenna  $m$ ,  $G_d$  is the spreading factor for a physical channel,  $E_{T,m}$  is the total received energy per chip for the physical channel from the transmit antenna  $m$ ,  $()^H$  is the Hermitean and  $\mathbf{p}_n$  is the channel impulse response for transmit antenna  $n$ , where vector  $\mathbf{p}_n$  contains the impulse response for all receive antennas.

14. A method as in claim 12, where determining coefficients operates at a chip level.

15. A method as in claim 12, where determining coefficients operates at a symbol level.

16. A method as in claim 12, where determining coefficients updates said equalizer coefficients continuously using a least mean squares (LMS) or a recursive least squares

(RLS) based algorithm.

17. A method as in claim 12, where determining coefficients occurs periodically at High Speed Downlink Packet Access (HSDPA) transmission time intervals (TTI).

18. A method as in claim 12, where said CDMA receiver comprises a Space Time Transmit Diversity (STTD) architecture receiver.

19. A method as in claim 12, where said CDMA receiver comprises a Double Space Time Transmit Diversity (STTD) architecture receiver.

20. A method as in claim 12, where said CDMA receiver performs equalization at a symbol rate.

21. A method as in claim 12, where the method operates with one of orthogonal or non-orthogonal space-time codes.